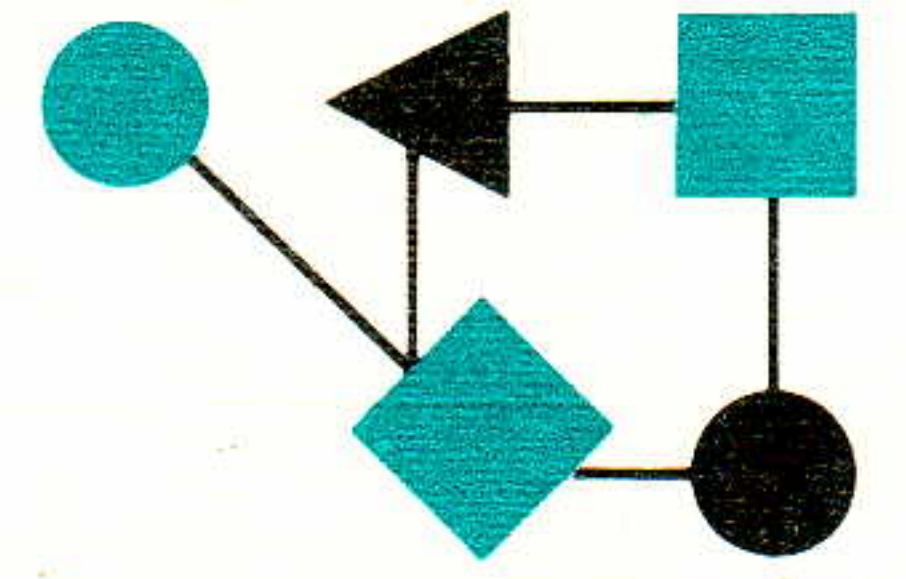# CONNEXIONS

The Interoperability Report

ConneXions - The Interoperability Report tracks current and emerging standards and technologies within the computer and communications industry.

In this issue:

Introduction from the Publisher

The computer interoperability world changes rapidly. How can you keep up with it? How can you decide what is even worth worrying about?

In order to rapidly deliver accurate information on new developments, Advanced Computing Environments is publishing this monthly newsletter. The purpose of *ConneXions--The Interoperability Report* is to connect all the parties with strong interests in achieving interoperability--users, vendors, and researchers. Information in this field changes often. We will track this new information, analyze it and report it to you so that you know what is real for today and what lies ahead for the future.

ConneXions will:

- **Report** what users are doing to solve networking problems and what they see as new requirements.
- **Analyze** what vendors are offering as products and what their concerns are for the future.
- **Describe** the problems that researchers are facing, their plans for solving them, and their progress to date.
- **Track** the standards setting and selecting bodies (ISO, CCITT, ANSI, IEEE, NBS, COS, MAP/TOP) as they progress in their efforts.

Planned articles will include interviews with leaders in all the communities of interest, articles on research in progress, protocol extension activities, product category analysis, standards activities, and features on user successes and failures. *ConneXions'* Editor-in-Chief, Ole Jacobsen, will interact with everyone who is influencing the field of interoperability.

Advanced Computing Environments will continue to sponsor conferences and workshops for you. We hope you will find *ConneXions* to be an important additional resource for tracking the developments in the interoperability field.

Daniel C. Lynch

Welcoming Letter from Vint Cerf
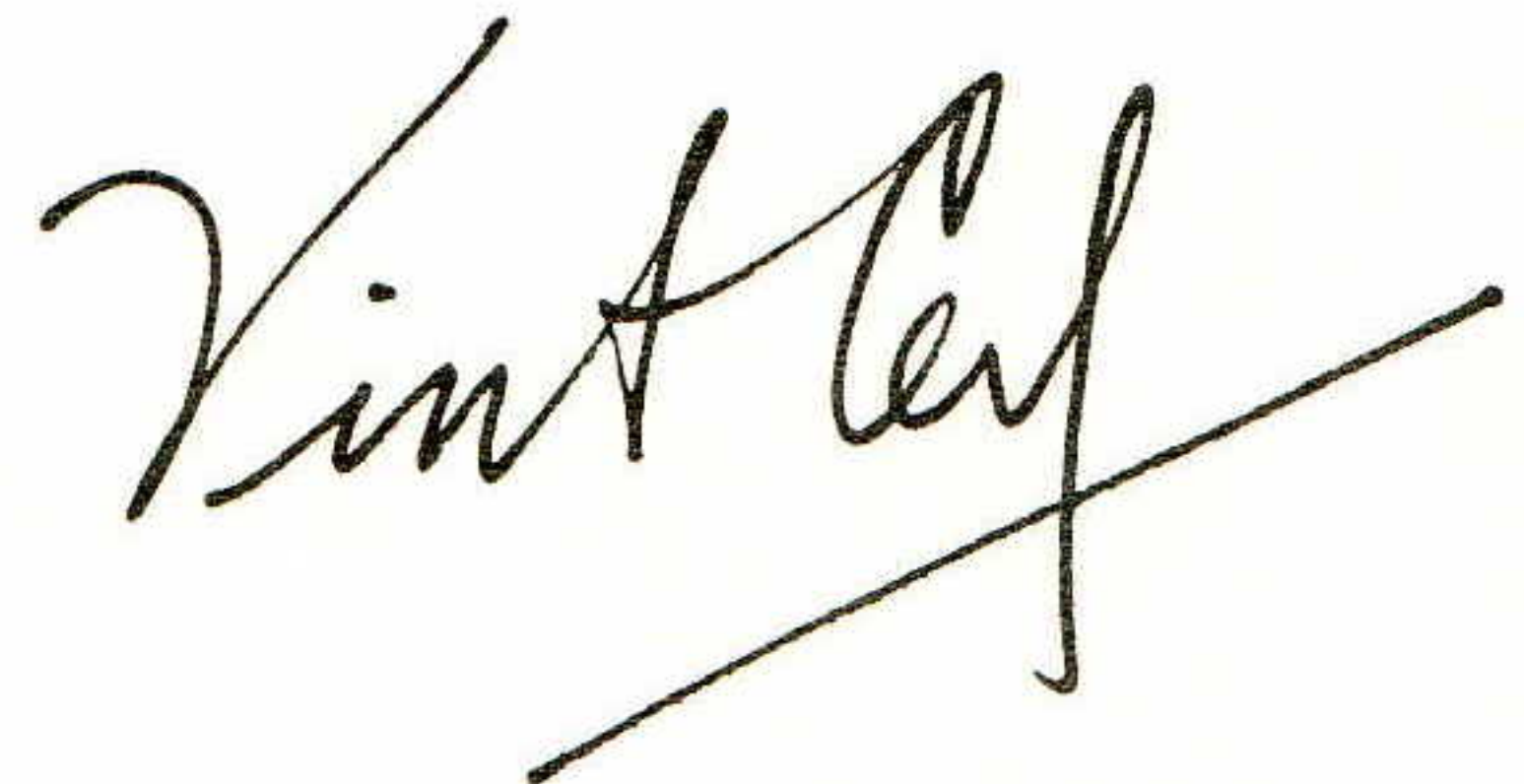
March 1, 1987

Rem acu tetigisti!

When Dan Lynch first told me about his plans for a newsletter about things TCP/IP, I was very glad that he was willing to try to satisfy the growing need for technical and topical information about the Internet protocols and the directions in which the user, vendor and research communities are heading in their applications.

Having spent parts of my career in academia, government and industry, I am finding that the propagation of the Internet protocol suite has relevance to all three communities. The government will benefit from commercially available products; industry will benefit from the sales of related products and services; and the academic community will benefit from membership in the increasing inter- and intra-mural linkage of university computing and communication resources.

Of course, none of the benefits will accrue unless the research, vendor and user communities are aware of the state of this technology, its potential problems and their solutions, future developments and research initiatives, and so on. Since not all members of the interested communities are connected together in an on-line fashion (yet!), this newsletter serves as a useful adjunct to the informal channels of information that now exist.

Interoperability among computer systems is essential if we are to benefit from the adoption of common communication protocols. But this benefit does not come for free! It must be earned and paid for by hard work, much interaction among the user, vendor and research communities, extensive testing and widely available and understandable documentation.

I am confident that Dan and his associates will succeed in their initiative to provide timely and high quality information to an enthusiastic and growing audience.

Vint Cerf

P.S. For those of you who wondered, the Latin salutation, loosely translated, is "Right on!" [Literally: "You've touched the thing with a needle." One hopes this does not refer to a balloon or other delicate, gas-filled object!]

Vint Cerf was Chief Scientist for the Information Processing Techniques Office and program manager for Internet research for DARPA from 1976 to 1982. At MCI he was vice-president of engineering where he developed the MCI Mail system from 1982 to 1986. Vint is currently vice-president of the Corporation for National Research Initiatives. He originally developed TCP/IP while he was a professor at Stanford University.

The RFC Story

If you want to read the gospel on a particular protocol, you're likely to be pointed to an RFC. Before a proposed protocol is accepted for use in the Internet, it is discussed, reviewed and often revised by members of the Internet Activities Board (see separate story) and other interested parties. This dialogue is captured in a set of technical notes called Requests For Comments (RFCs). Their keeper and publisher is Dr. Jon Postel of USC-ISI.

RFC 001 "Host Software"

A reading of all the RFCs paints a fascinating picture of the development of the Internet. RFC 001, dated April 7th, 1969, was written by Steve Crocker and is entitled "Host Software". The Arpanet was just beginning to become a reality. BBN had already specified the software of the IMPs (nowadays called PSNs), and it was now time for the HOST working group to define the network software that would run on the hosts. To quote from RFC 001:

> "During the summer of 1968, representatives from the initial four sites met several times to discuss HOST software and initial experiments on the network. There emerged from these meetings a working group of three, Steve Carr from Utah, Jeff Rulifson from SRI, and Steve Crocker of UCLA, who met during the fall and winter. The most recent meeting was in the last week of March in Utah. Also present was Bill Duvall of SRI who has recently started working with Jeff Rulifson.
>
> Somewhat independently, Gerard De Loche of UCLA has been working on the HOST-IMP interface.
>
> I present here some of the tentative agreements reached and some of the open questions encountered. Very little of what is here is firm and reactions are expected."

Technical specifications aimed at implementors

Many of the issued RFCs have become accepted standards without further ado, a phenomenon which has led some cynics to say that RFC stands for "Requirements For Compliance". The authors of RFCs have from time to time displayed some sense of humor. One that comes to mind is Mark Crispin's "Telnet-Randomly-Lose Option" (RFC 748) issued on April 1, 1978. But for the most part, RFCs contain technical specifications, usually written such that programmers can actually implement protocols from them.

In some cases the RFC will become an "Official ARPA Internet Protocol" and will be added to a list of such. The official list is itself an RFC which is issued periodically. (Currently RFC 991). This RFC also contains important comments about the current set of protocols and should definitely be read in conjunction with other RFCs.

The RFC Story *(continued)*

How to get RFCs

You can order hard copies of RFCs from the DDN Network Information Center, or FTP them from the SRI-NIC.ARPA host. The NIC also maintains a list of RFCs by topic and, of course, the all-important numerical RFC Index. Most RFC's cost $5.00 per copy, apart from a handful which are over 100 pages and cost $10.00. A new RFC Subscription Service is now also available from the NIC; for $200.00 you'll get 12 months worth of of RFCs.

RFC 1000 "A Reprise"

Soon RFC 1000 will be issued. It is intended to be a reference guide and will provide a historical account of the Requests for Comments issued between 1969 and 1987, (RFC 001-999). This reference guide will also identify and categorize particular RFCs that may be of interest. These documents will be cross-referenced to provide information on what items are current, obsolete, or superseded.

Getting Information

- DoD protocol documentation may be ordered from:

  DDN Network Information Center
  SRI International, Room EJ291
  333 Ravenswood Avenue
  Menlo Park, CA 94025
  (800) 235-3155 or (415) 859-3695

- CCITT and ISO documents may be ordered from:

  OMNICOM, Inc.
  501 Church Street, N. E.
  Suite 304
  Vienna, VA 22180
  (703) 281-1135

The Internet Activities Board

In the ARPA Internet, both operational and R&D issues are monitored by The Internet Activities Board (IAB). The IAB is a governing committee that divides its work among a number of Task Forces which work on various aspects of Internet research. We will be bringing you reports from some of their deliberations in future issues of *ConneXions*. The Task Forces are:

- End-to-End Systems
- Privacy and Security
- Scientific Applications
- Autonomous Systems
- Internet Engineering
- Internet Architecture
- Applications
- International Research Internet
- Tactical Internetting
- Robustness and Survivability

Protocol Testing for TCP/IP

In the early years of TCP/IP products things were simple. There were only a few different implementations in the field and their implementors all talked to each other regularly. Now that we have over 100 implementations it is not the case that all implementors communicate with each other to eliminate incompatibilities. A simple case may illustrate the point.

Silly Window Syndrome

There is a bad strategy for filling the data pipeline in TCP that can cause extremely low data rates to be experienced. It is called Silly Window Syndrome (SWS). The standard distributed version of 4.2 Berkeley Unix has this implementation bug in it and some vendors have fixed it, while many have not. (4.3 bsd has it fixed.) The causes and cures for SWS are dealt with completely in RFC 813 by David Clark from MIT. So we might ask:

Is testing needed?
Who will pay for it?
How soon can it happen?
Is that too late?

Financial support of TCP/IP could come from one of three sources:

Who will pay for testing?

- Government pays for the testing lab.
- Vendors pay.
- Private enterprise sets up a facility and charges vendors for testing.

Or we just forget about testing TCP/IP.

Will users ever demand it?

Since it appears that testing most benefits the users, is there enough political clout in the user community to demand that TCP/IP products be tested before being sold?

In future issues of *ConneXions* we will explore the testing issue for TCP/IP. We will explore these matters in detail. We also solicit your views. We want to hear from users.

They pay the final bills.
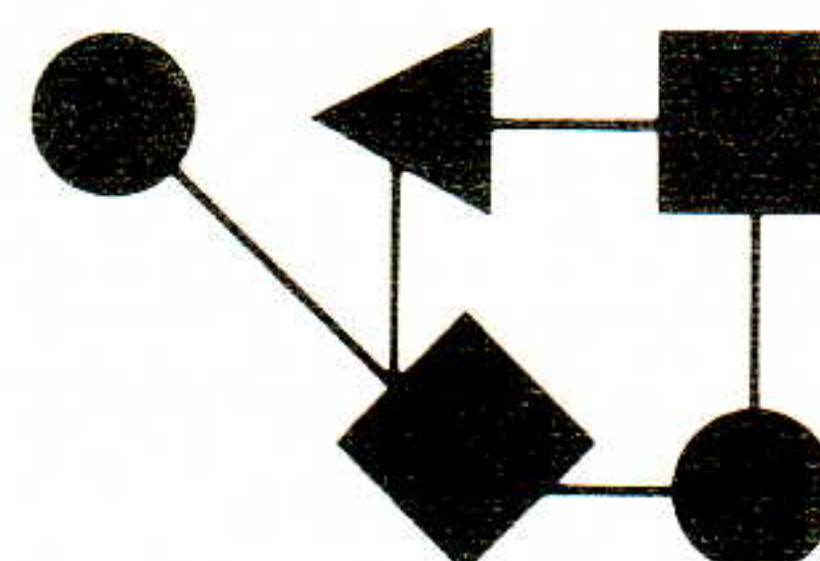
What is going on with Netbios and TCP/IP?

About a year ago a number of vendors independently decided to make it possible for IBM PC applications (Netbios software interface) to run in a TCP/IP networking environment. These vendors already offered TCP/IP networking products and wanted them to interoperate with the growing number of Netbios applications. Products were announced by a number of vendors.

Interoperability requires detailed agreements

Then along came the Mitre Corporation (in the role of coordinating large system purchases for the DoD) to ask the simple question: *Will these different implementations of Netbios on TCP/IP interoperate with each other?* Sadly, the answer was *"no"*. Each vendor had chosen a different means of using TCP/IP to communicate with the Netbios interface. All it takes is a one-bit difference in any interface to make communication impossible. Mitre and the interested vendors formed a working group to examine the requirements and write a common specification that all could use.

The two major technical challenges facing this group were:

Multiple operating system support

- Any "reasonable" operating system must be able to implement the specification.
- Netbios applications should be able to operate in the Internet environment as well as in local networks.

Ironing out the details of the first point took a while. The group wanted to be sure each operating system type could efficiently implement the new common interface to Netbios. (The idea is that applications running on Unix, Xenix, MVS, VM, VMS, CTOS, etc. would be able to communicate with Netbios applications running in the MS-DOS and PC-DOS world.)

Internetworking for Netbios sought

The second major challenge they faced is a key one: communication between separate networks. The scope of Netbios operation was originally intended only for a single network. Problems such as the one described to the right had to be solved.

These problems have been addressed by the vendors and a two-step approach has been chosen for resolving them. In future articles we will describe the solutions to these problems and thereby shed more light on inter-operability in a PC environment.

Problem: Netbios Naming in an Internet

In the Netbios world communicating entities (say, two programs) all have names. Names are obtained by a simple announcement scheme. If you want the name "Fred" you just broadcast your claim to the name "Fred" to everyone else on the network and if no one objects, you are "Fred". (If someone objects, you have to pick another name.) In the Internet case this scheme presents two problems:

- What happens when two formerly separate networks get connected (by a bridge/router/gateway) and there is a "Fred" on each one?

- True broadcasting in the Internet is forbidden. It would quickly drown the universe.

Multi-Vendor Support

Just in case you're thinking that TCP/IP is a protocol suite of limited use, take a look at this list! Some 150 vendors now offer products which support TCP/IP and more are under development. If you know of other companies that should be added to the list be sure to let us know. We will be publishing this list from time to time.

ACC	Excelan	Novell
Alliant	Fibronics-Spartacus	Opus
Altos	Ford Aerospace	Oracle
AMD	Fortune	Panda Programming
Amdahl	Frontier Technologies	Phoenix Technology
Apollo Computer	FTP Software Inc.	Plexus
Apple Computer	GE Calma	Prime
Applicon/Schlumberger	General Electric	Process Software
Applitek	Gold Hill Computers	Proteon
Arete	Gould	Protocom Devices
ARINC Research	GTE	Pyramid
Associated Computer Experts	Harris	Relational Technology
AT&T	Hemispheres Hi-Tech	Research Equipment Inc.
Auscom	Hewlett-Packard	Ridge Computer
Aydin Monitor Systems	Honeywell	SAIC
BBN Communications	IBM	Santa Cruz Operation
BBN Labs	Imagen	SCI Inc.
BDM	Interactive Systems	Scope
Beame & Whiteside Software Ltd.	Integrated Solutions	Sequent
Bellcore	Intergraph	Silicon Graphics
Bridge Communications	Intermetrics	SMS Data Products Group
Britton Lee	Internet Systems Corp.	Software Kinetics Ltd.
Butler & Curless	KEE	Software Systems Associates
Canaan Computer	Kinetics	SPARTA
Celerity Computing	Lachman Associates	Spider Systems Inc.
Centram Systems	Lisp Machine Inc.	SRI International
Charles River	Little Machine Inc.	Sterling Software
CISCO	Locus	Stride Micro
cisco Systems	Los Alamos National Labs	Sun Microsystems
Claflin & Clayton	Marble Associates Inc.	Symbolics
Communication Machinery Corp.	MARI	Sytek
Computer Network Technology	Masscomp	Tandem
Concurrent Computing	Maxim	Tektronix
Control Data Corporation	MICOM-Interlan	Texas Instruments
Convergent Technologies	Microport	THG
Convex Computer	Mips	3Com
Computer Science Corporation	Mitre	Tracor
Counterpoint	Motorola	Ungermann-Bass
Cray Research	Mt Xinu	Uniq
Cydrome	NBI	Unisoft
Dana Group	NCR	Unisys
Data General	NCR Comten	Univation
Datapoint	Network General Corp.	Valid Logic
Dawn Systems	Network Research Corp.	Vitalink
Digital Equipment Corporation	Network Solutions	Wang
Elxsi	Network Strategies	Wollongong Group
Encore	Network Systems Corporation	Xerox
Epilogue Technology	Nixdorf	Xios Systems

Gateways

If you have more than one campus/corporate network, you have probably already considered the possibility of connecting the networks together by means of a gateway.

ConneXions will be bringing you a series of articles about gateways, and we hope to unravel the mysteries of what is at first glance a simple concept. Today's article is merely a cursory introduction to a subject which we will discover is very complex indeed.

Also called IP Routers
The term "gateway" is unfortunately used to mean a variety of things. Gateways may be used to tie together different kinds of physical networks or provide functional mapping at the application level. A host connected to two networks (such as BITNET and Arpanet), and providing mail-relaying between each network, would also be called a gateway. The kinds of gateways to be discussed here operate at the Internet Protocol (IP) level (and are often called "IP Routers"). Their function is to bridge together two or more networks of <u>similar</u> architecture.

Achieve network separation and interconnection
There may be many reasons for expanding from a single set of nodes to an internet of networks connected by gateways. The original Arpanet placed a limitation on the number of nodes, but this in itself was not the major reason gateways were needed. There were a number of different technologies emerging such as packet radio nets, satellite nets, and local area networks. All were based on TCP/IP, but with very different underlying technologies. Sharing resources and information in such an environment was certainly important, but of equal importance was the ability to isolate one network from another by means of the gateway.

Gateway is a special host
A gateway is really just a special host which is connected to two (or more) networks as shown in Figure 1. Note that this gateway has <u>two addresses</u>, --one on network A and one on network B--, and performs address translation between the two. Hosts on each network maintain (static or dynamic) tables which allow them to route packets to other networks via the gateways. The gateways exchange reachability and routing information by means of an interior gateway protocol (IGP). [In the Internet case this is GGP, see RFC 823]. A set of gateways that speak the same IGP is called an Autonomous System, (AS) and is usually controlled by a single administration.
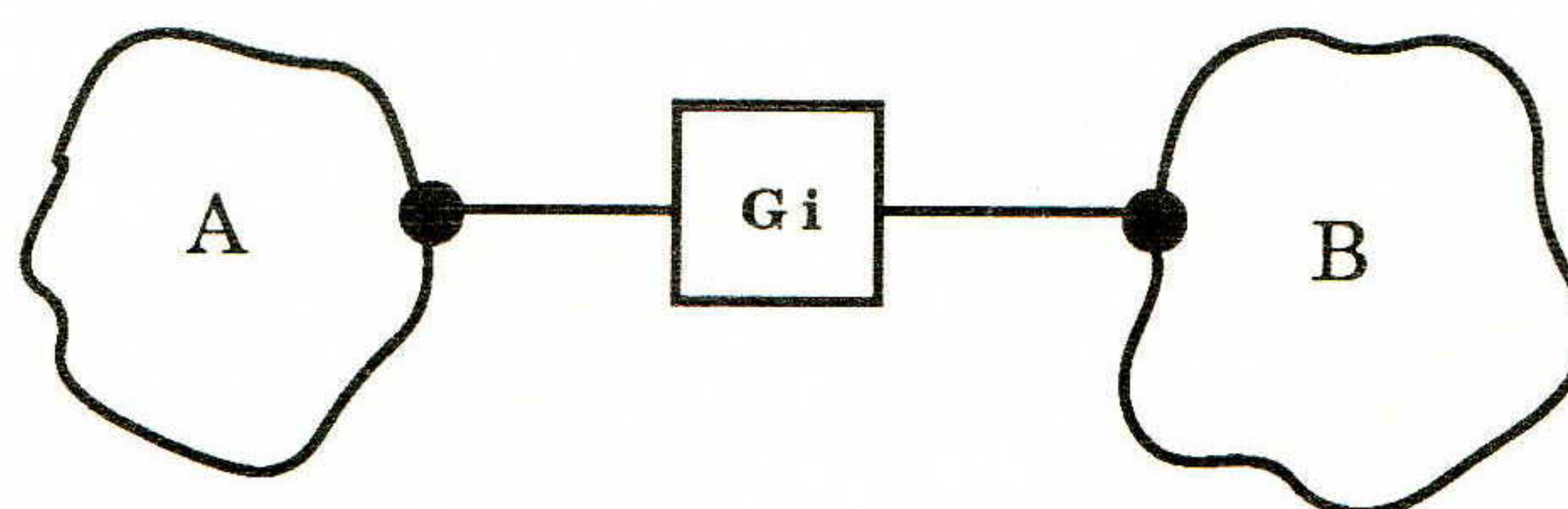

Figure 1

Autonomous Systems may be connected together by another set of gateways as shown in Figure 2. In this case an exterior gateway protocol (EGP) is used to exchange reachability and routing information.
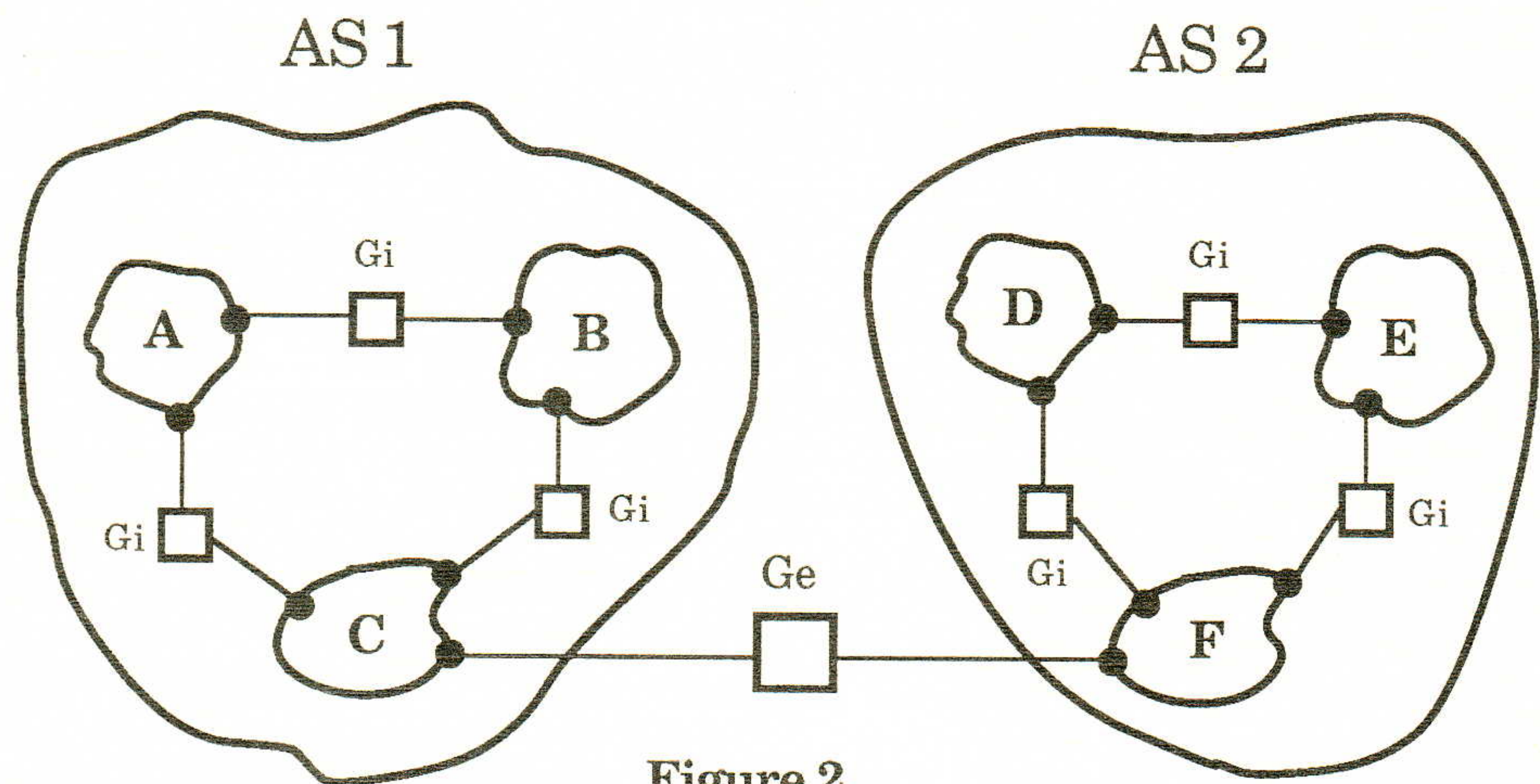

Figure 2

From a vendor or a user point of view this situation is complicated by the fact that there is more than one IGP in existence. The IGPs may be proprietary or undocumented, but we are fortunate to have one standard EGP (RFC 904) which - at least in principle - should allow networks from different vendors to interoperate. [As we explore the mysteries of gateways we will discover that this may, in fact, not always be possible.]

New EGP being considered

Important changes will be occurring in the EGP world. The Internet Engineering Task Force is looking at the future of EGP in light of the rapidly expanding Internet. The news from the recent meeting held at NASA Ames is that they are considering both a new standard (and documented!) IGP, and the interactions between such a protocol and a future version of EGP -"Son of EGP". A paper is being drafted which defines the functional requirements for a new network routing architecture in the Internet. We will bring you more information about this work as it emerges.

From The Editor

You are holding the Premiere Issue of *ConneXions - The Interoperability Report*. In an attempt to satisfy the need for information exchange between users, vendors and the R&D community, we will be publishing this newsletter.

You've probably already discovered that networking is hard, and that reading the written RFCs just isn't enough. There is a great deal of protocol "folklore" which is difficult to track, especially if you don't have access to the ARPA Internet (since a fair amount of this discussion goes on via electronic mailing lists).

Research task forces reporting

In addition, the research people hold regular Task Force meetings and *ConneXions* will be reporting on the issues of importance to the vendor/user community. We would also like to act as a conduit in the other direction: users and vendors should feel free to address their concerns and give input to the R&D community via this publication.

Tremendous growth of TCP/IP

With the emergence of ISO it is probably true to say that TCP/IP is a protocol with a finite lifetime, but I am encouraged to see a tremendous growth in the number of implementations and products based on TCP/IP coming out of the vendor community. Some of you knew me as the person who cataloged this information in the DDN Protocol Implementations and Vendors Guide, published by the SRI NIC (Network Information Center). Having held my finger on the pulse of TCP/IP, so to speak, I am sure that this protocol suite will be with us for many years to come.

ISO is coming --no doubt about that-- and we think *ConneXions* should be following this development with an emphasis on migration from DoD to ISO protocols. There are already several migration strategies and government policy statements which will affect the timing of such a protocol change.

We will be covering alot of ground with this publication. Here are some of the areas we will be exploring, but the list is by no means complete:

Future topics

- Gateways and Autonomous Systems
- Netbios
- More efficient TCP/IP implementations
- Congestion (aka The ARPA Internet "Success-Disaster")
- The Naming Domain System
- Security and Authentication
- Testing and Certification
- War Stories or "How we do networking at XYZ"

One thing is clear: We need your input. I know that there are a large number of wizards in the user, vendor, and R&D communities. I encourage you to step forward and help us make this publication a success.

Ole J. Jacobsen

Additional Sources of Information

We hope you were able to join us at the TCP/IP Interoperability Conference, March 16-19 in Monterey, CA. That conference was heavily attended by users, vendors and researchers. We have plans for two more conferences in 1987 that may interest you.

The first is an ISO Implementation Seminar to be held this September in Monterey, CA. This seminar will describe a complete implementation of the ISO stack of protocols by a team of people who have been working on it for 2 years.

The second is a TCP/IP Interoperability Conference which is scheduled for early December in Washington, DC. It will focus on new developments in TCP/IP.

If you are not a subscriber to *ConneXions* and wish to receive the detailed information on these upcoming events please contact Advanced Computing Environments so that we may place you on our mailing list.

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